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Projection Objective having Adjacently Mounted Aspheric Lens Surfaces

Related Applications

This is a continuation application of International patent application PCT/EP 00/13148, filed Dec. 22, 2000, and claiming priority of U. S. provisional application 60/173,523, filed Dec. 29, 1999, and German applications 100 02 626.5 and 100 21 735.7, filed January 22, 2000 and May 4, 2000, respectively.

Background of the Invention

International patent publication WO 99/52004 discloses catadioptric optic projection objectives which include a plurality of aspheric lens surfaces. For example, the projection objective shown in FIG. 4 includes 12 aspheric lens surfaces for 15 lenses. The manufacturing costs of aspheric lens surfaces with the accuracy required in microlithography are very high. Accordingly, these objectives are of little interest in the marketplace because of the many required aspheric lens surfaces.

European patent publication 0 322 201 discloses an optical projection system especially for photolithography. The projection objective known from this publication includes five lens groups. The first, second, third and fifth lens groups each have only one lens. In part, the lenses are provided with aspheric lens surfaces. An aspheric object end mounted lens surface of the fifth lens group follows an aspheric lens surface mounted in the fourth lens group at the image end.

European patent publication 0 851 304 discloses the adjacent mounting of aspheric lens surfaces in a projection objective. These aspheric lenses are supported so as to be displaceable in the radial direction. The projection objective is matched via

the relative movement of the lenses. The aspheric lens surfaces are especially rotationally unsymmetrical because of the possibility of displacing the aspheres in radial direction with respect to each other. Because of the movable support of the aspheric lenses, this arrangement is not suitable for every projection objective because projection objectives designed especially for short wavelengths react sensitively to the smallest position change of the individual lenses. Accordingly, the position stability, which is achievable because of the special support of the lenses, is not sufficient in order to reliably ensure a good imaging quality.

German patent publication 198 18 444 discloses a projection optic arrangement having a purely refractive projection objective which includes six lens groups G1 to G6. In this projection objective, the lens groups G1, G3 and G5 have positive refractive power. The lens groups G2 and G4 have negative refractive power. To correct imaging errors, some lenses, especially in the fourth and fifth lens groups, have aspheric lens surfaces.

German patent publication 199 42 281.8 discloses additional projection exposure objectives which have six lens groups. The second lens group and the fourth lens group have negative refractive power. In the projection objectives known from this publication, lenses having aspheric lens surfaces are preferably arranged in the first three lens groups. A minimum number of spherical lens surfaces are arranged between the aspheric lens surfaces. This minimum spacing between the aspheric lens surfaces appears necessary so that the utilized aspheric lenses can develop their optimal effect.

From United States Patent 4,871,237 it is already known to match an objective in dependence upon barometric pressure via the

refractive index of a fill gas in the lens intermediate spaces. For example, spherical aberration, coma and other imaging errors can be corrected with a suitable combination of intermediate spaces.

United States 5,559,584 discloses introducing a protective gas into the intermediate spaces between a wafer and/or a reticle and the projection objective in a projection exposure system for manufacturing microstructured components.

Summary of the Invention

It is an object of the invention to provide a projection objective and a projection exposure system as well as a method for manufacturing microstructured components. These components are improved with respect to the imaging quality and the resolution capacity. Furthermore, it is an object of the invention to reduce manufacturing costs.

The projection objective of the invention defines a maximum lens diameter (D2) and includes: a plurality of lenses defining an object plane (0) and an image plane (0'); at least two of the lenses having respective mutually adjacent lens surfaces which are aspheric to define a double asphere; the double asphere being mounted at a distance from the image plane (0') corresponding at least to the maximum lens diameter (D2); the lenses of the double asphere defining a mean lens diameter; and, the mutually adjacent lens surfaces being mounted at a spacing from each other which is less than half of the mean lens diameter.

In a projection objective having a plurality of lenses, the measure of arranging the double asphere at a spacing of at least the maximum lens diameter of the objective away from the image plane (especially the wafer plane), improves the imaging qualities of a projection objective in comparison to a projection

objective without such double aspheres. In the above, at least two mutually adjacent mounted lens surfaces are aspheric and this is identified as a double asphere. The spacing between the aspheric lens surfaces of the double asphere is maximally half the lens diameter of the mean diameter of the double asphere. The numerical aperture can especially be increased in a refractive projection objective with the use of at least one double asphere in that the first convex form is shortened so that, at a constant length of the projection objective, the third convex form experiences an increase of the numerical aperture of approximately 0.03 to 0.05.

Especially in purely refractive projection objectives, the use of double aspheres with an arrangement in the first three lens groups has been shown to be especially advantageous.

In lithographic objectives, there are particular locations, which operate especially well on difficult to control aberrations, when these locations are aspherized. Precisely here it is purposeful to utilize especially the effectiveness at the corresponding location via a complex aspheric function. The region of the first restriction and the end of the second convex form as well as regions behind the diaphragm are predestined. Since the technical realization of complex aspheres is subjected to technical limits, the complex asphere functions are realized by means of double aspheres. In this way, a still more extensive correction is possible and the aspheres of the double asphere are technically realizable.

Furthermore, it has been shown to be advantageous to provide aspheric lens surfaces as aspheric lens surfaces of the double asphere. The radius of the aspheric lens surfaces of the best-fitting spherical lens surface (identified as the profile

radius) differ very little. Preferably, the reciprocal values of the profile radius or radii of the double aspheres deviate less than 30% from each other. As a reference value, the reciprocal value of the larger radius in magnitude is applied.

It has been shown to be especially advantageous that the apex radii of the aspherical lens surfaces of the double aspheres differ by less than 30% with reference to the larger apex radius in magnitude.

In the area of microlithography, the developmental work is directed to increasing the resolution. On the one hand, the resolution can be increased by increasing the numerical aperture, utilizing ever smaller wavelengths and even by correcting the occurring imaging errors. For an increase of the image end numerical aperture, the last convex form of the objective arranged at the image end is increased. However, it is problematic that only a fixed pregiven space can be made available for the objective. Accordingly, in order to provide a larger numerical aperture, it is therefore necessary to save space in other regions of the objective.

It has been shown to be advantageous to provide the space needed for increasing the numerical aperture by shortening the first convex form. With the first convex form, especially the input telecentrics and the distortion are corrected. By utilizing double aspheres, it is possible to correct the input telecentrics as well as the distortion with ease and at a short distance. With the double asphere, a variable adjustment of the location is made available at a short distance. With the possibility of varying the location, the distortion can be corrected. Especially the input telecentrics is corrected because the angle can be flexibly influenced.

Corrective means has already been made available in the input region of the objective especially with the use of a double asphere in a refractive projection objective in the region of the first two lens groups, that is, up to and including the first lens group of negative refractive power. Accordingly, the corrective means, which is required in the third convex form, are reduced for ensuring a uniform or constant imaging quality.

Furthermore, by providing a double asphere in the forward region of the objective, especially up to the second restriction, the number of lenses is reduced. This operates advantageously on the manufacturing costs.

In purely refractive projection objectives, it has been shown to be advantageous to provide aspheric lens surfaces in the forward region of the objective ahead of the second restriction to improve the imaging quality. For example, for a numerical aperture of 0.83, the deviation from the wavefront of a spherical wave is reduced to less than 6 mλ with a field of 8x26 mm^2 referred to 248 nm.

The imaging characteristics of the objective can be changed because of fluctuations of the atmospheric pressure. In order to compensate for such pressure fluctuations, it has been shown to be advantageous to charge an intermediate space between two lens surfaces with pressure in a targeted manner so that pressure changes, especially of the atmospheric pressure, can be compensated. Furthermore, the targeted application of pressure can be used for a further reduction of imaging errors.

Furthermore, it has been shown to be advantageous to provide at least one of the end plates with a pressure manipulator so that a curvature of the plate or lens can be generated with a two-sided application of pressure of the particular lens or the

particular plate. For a three-point support of the end plate and an application of pressure of the gas space, the three-waviness during operation is corrected in a targeted manner by means of the through-bending of the end plate. With an n-point support, an n-waviness can be corrected.

A force, which is directed in the z-direction, for curving the lens can be introduced via coaxially mounted actuators, especially, piezos. The force, which is introduced by the actuators, is directed to the lens center point.

Brief Description of the Drawings

The invention will now be described with reference to the drawings wherein:

FIG. 1 shows a projection exposure system;

FIG. 2 shows a projection objective for the wavelength 157 nm having a numerical aperture of 0.8;

FIG. 3 is a projection objective for the wavelength 248 nm having a numerical aperture of 0.83;

FIG. 4 is a projection objective for the wavelength 248 nm having a numerical aperture of 0.9;

FIG. 5 is a projection objective for the wavelength 193 nm having a numerical aperture of 0.85;

FIG. 6 is a projection objective for the wavelength 193 nm having a numerical aperture of 0.9;

FIG. 7 is a projection objective for the wavelength 157 nm having a numerical aperture of 0.9;

FIG. 8 is a projection objective for the wavelength 193 nm having a numerical aperture of 0.9;

FIG. 9 is a catadioptric projection objective having a double asphere for the wavelength of 157 nm and having a numerical aperture of 0.8.

Description of the Preferred Embodiments of the Invention

Referring to FIG. 1, the principle configuration of a projection exposure system is described. The projection exposure system 1 includes an illuminating unit 3 and a projection objective 5. The projection objective 5 includes a lens arrangement 19 having an aperture diaphragm AP. An optical axis 7 is defined by the lens arrangement 19. Different lens arrangements are explained in greater detail hereinafter with respect to FIGS. 2 to 6. A mask 9 is mounted between the illuminating unit 3 and the projection objective 5. The mask 9 is held in the beam path by means of a mask holder 11. Such masks 9, which are used in microlithography, have a micrometer-nanometer structure which is imaged demagnified on an image plane 13 by means of the projection objective 5 up to a factor of 10, especially by the factor 4. In the image plane 13, a substrate 15 or a wafer is held. The substrate 15 or wafer is positioned by a substrate holder 17.

The minimal structures, which can still be resolved, are dependent upon the wavelength λ of the light, which is used for the illumination, as well as in dependence upon the image side numerical aperture of the projection objective 5. The maximum attainable resolution of the projection exposure system 1 increases with falling wavelength λ of the exposure illuminating unit 3 and with an increasing image end numerical aperture of the projection objective 5.

The projection objective 19 shown in FIG. 2 includes six lens groups G1 to G6. This projection objective is designed for the wavelength 157 nm. The first lens group G1 or first convex form is defined by the lenses L101 to L103 which are all biconvex lenses. This first lens group has positive refractive power.

The last lens surface of this lens group G1, which is mounted at the image end, is aspherized. This lens surface is identified by AS1. The last lens of this lens group G1 is a biconvex lens which can be clearly assigned to the first lens group.

The lens group G2 or first constriction, which follows the lens group G1, includes the three lenses L104 to L106. This lens group G2 has negative refractive power and defines a restriction. An object end mounted lens surface AS2 of the lens L104 is aspheric. Furthermore, the image end mounted lens surface of lens L106 is aspheric. A double asphere is formed by the two lens surfaces AS1 and AS2.

The lens group G3 has positive refractive power and is defined by the lenses L107 to L111. The last lens surface of this lens group is the lens L111 which is arranged at the image end and is aspherized. This lens group is a convex form.

The second lens group G4 of negative refractive power continues from the third lens group. This lens group G4 is defined by the lenses L112 to L115. This lens group defines a constriction.

The fifth lens group G5 has the lenses L116 to L125 and has positive refractive power and includes an aperture diaphragm AP which is mounted between the lens L119 and the lens L120.

The sixth lens group G6 is defined by the lenses or plates L126 and L127. This objective is designed for the wavelength 157 nm having a spectral bandwidth of the illuminating source of 1.5 pm and the lenses L113 to L115 and L119 for this objective are of sodium fluoride. With the use of a second material (here sodium fluoride), especially chromatic errors can be corrected. The chromatic transverse errors are significantly reduced because of the use of NaF in the first restriction. Even

the chromatic longitudinal error is somewhat reduced. The largest individual contribution to correction of the chromatic longitudinal errors is achieved with the use of NaF in the lens group G5.

The positive lenses L116 to L118 of the lens group G5 continue from the lens group G4 and are of lithium fluoride. With the use of lithium fluoride at this location in the objective, especially the monochromatic correction is facilitated because only small individual refractive powers are needed for achromatization because of the larger dispersion distance of lithium fluoride and sodium fluoride than of calcium fluoride and sodium fluoride. The basic configuration does not differ so significantly from a chromatic objective because of the special material selection.

The two positive lenses, which are arranged after the diaphragm, are likewise of lithium fluoride and also make, as explained with respect to the lithium lenses mounted ahead of the diaphragm, an important contribution to the correction of the chromatic longitudinal error.

The lens L122, whose two surfaces run almost at a constant spacing to each other, comprises calcium fluoride. The lens is very significant for the monochromatic correction and has only a slight influence on the chromatic longitudinal error.

The last three lenses of the fifth lens group G5, L123 to L125, are of lithium fluoride. These lenses supply a smaller but nonetheless very valuable contribution to the correction of the chromatic longitudinal error.

The sixth lens group includes the lenses or planar plates L126 and L127 which comprise calcium fluoride.

This objective is designed for illuminating a field

of 8x26 mm. The structural length from position 0 to position 0' is 1,000 mm. The numerical aperture is 0.8. The precise lens data are set forth in Table 1.

The aspheric surfaces are in all embodiments described by the equation:

$$P(h) = \frac{\delta \cdot h \cdot h}{1 + \sqrt{1 - (1+K) \cdot \delta \cdot \delta \cdot h \cdot h}} + C_1 h^4 + \ldots + C_n h^{2n+2} \qquad \delta = 1/R$$

wherein: P is the arrow height as a function of the radius h (elevation to the optical axis 7) with the aspheric constants C_1 to C_n given in the Tables. R is the apex radius.

The projection objective shown in FIG. 3 includes six lens groups G1 to G6 having the lenses L201 to L225 and a divided end plate (L226, L227). This objective is designed for the illumination wavelength 248 nm. The space required for this projection objective 19 amounts precisely to 1,000 mm from object plane 0 to image plane 0'. At the image end, this objective 19 has a numerical aperture of 0.83. The field which can be exposed by this projection objective is 8x26 mm.

The first lens group G1 includes the lenses L201 to L204 of which the lenses L201 to 203 are biconvex lenses.

The first lens L204 of the lens group G1 has an aspheric form on the image end lens surface. This asphere is identified by AS1.

The second lens group G2 includes the three lenses L205 to L207. These lenses have a biconcave form and the lens surfaces of the lenses L205 and L207, which face toward the respective bounding lens groups, are aspheric. The aspheric lens surface of the lens L205 is identified by AS2. In this way, a

double asphere is formed by the two mutually adjacent aspheric lens surfaces AS1 and AS2. The last lens of the lens group G2 is provided as aspheric on the side facing the wafer.

The third lens group includes the lenses L208 to L21. With this lens group G3, a convex form is provided. The lens L211 is made aspheric on the image end lens surface.

The fourth lens group G4 is formed by the lenses L213 to L215 which are all configured to be biconcave. This lens group G4 is the second lens group of negative refractive power. With this lens group, a restriction is formed.

The lens group G5 includes the lenses L216 to L225. An aperture diaphragm is mounted between the lenses L218 and L219. The diaphragm curvature between the peripheral ray at the diaphragm at a numerical aperture of 0.83 and the intersect point of the chief ray with the optical axis is 30.9 mm. With this lens group, a convex form is provided.

The sixth lens group G6 includes the lenses L226 and L227 and these lenses are configured as planar plates.

The precise lens data of this projection objective 19 are set forth in Table 2. For the same structural length of the objective from 0 to 0' of 1,000 mm compared to FIG. 2, the aperture is increased further to 0.83 with an excellent correction.

The projection objective shown in FIG. 4 includes six lens groups having the lenses L301 to L327. The objective is designed for the illuminating wavelength 248 nm and has a numerical aperture of 0.9.

The first lens group G1 includes the lenses L301 to L304. This lens group has a positive refractive power. The refractive power especially of lenses L302 to L303 is very low. The focal

length of this lens at L302 is 1077.874 mm and is -92397.86 mm at L303.

A lens group of negative refractive power G2 continues from this last lens group and is formed by the three lenses L305 to L307. The first lens surface of this lens group G2 is arranged at the image end and is made aspheric and is identified by AS1. The lens surface of lens L305 facing toward the lens surface AS1 is made aspheric so that a double asphere is formed by the lens surfaces AS1 and AS2. Between these aspheric lens surfaces AS1 and AS2, there is a clearly recognizable spacing provided in contrast to the previous embodiment. In this double asphere, the equidistant arrangement of the surfaces AS1 and AS2 is no longer completely utilized and the double asphere opens somewhat toward the outside.

The next lens group G3 has a positive refractive power and includes the lenses L308 to L311. This lens group G3 includes an aspheric lens surface and this aspheric lens surface is mounted on the image side on the lens L311.

The second lens group of negative refractive power G4 includes the lenses L312 to L315. The lens surface of the lens L314 mounted at the image end is made aspheric.

The next lens group G5 has a positive refractive power and includes the lenses L316 to L325. The diaphragm AP is mounted between the lenses L319 and L320. The two mutually adjacent lens surfaces of lenses L321 and L322 are aspheric and are identified as AS3 and AS4. A double asphere is formed by these aspheres AS3 and AS4. An air space is enclosed by the surfaces AS3 and AS4. With this double asphere, especially the spherical aberration and the sine condition at high aperture are better decoupled and easily corrected.

The sixth lens group includes the lenses L326 and L327 which are configured as thick planar plates. The intermediate space defined by these planar plates is chargeable with an overpressure and an underpressure and/or with a gas for compensating fluctuations of the atmospheric pressure. For more extended correction possibilities, it can be provided that at least one of the planar plates with or without refractive power (that is, also as a lens which is clearly thinner) compensates n-waviness under pressure variation and point mounting. For a targeted deformation of the lens, piezo actuators can be provided on the outer periphery.

The structural length of this objective from object plane 0 to image plane 0' is 1139.8 mm. The numerical aperture at the image end amounts to 0.9 with an exposable field of 27.2 mm in the diagonal. The precise lens data are set forth in Table 3.

The projection objective 19 shown in FIG. 5 includes six lens groups G1 to G6. This projection objective is designed for a wavelength of 193 nm. The first lens group G1 includes the lenses L401 to L404. Already the first object end mounted lens surface of the lens L401 is made aspheric. This asphere acts especially positively on dish-shaped traces and distortion with excellent entry telecentrics because this asphere is mounted at the location at which the best beam separation exists for the high-aperture lithographic objective.

The lens surface of lens L404, which is provided at the object end, is aspheric and is identified by AS1. A double asphere is formed by this lens surface AS1 and the lens surface of the lens L405 which is mounted at the image end and is likewise aspheric and is identified by AS2. This double asphere operates especially positively on dish-shaped traces while

simultaneously providing good correction of the image errors caused by the high aperture. With increasing radial distance from the optical axis, the surfaces AS1 and AS2 of the double asphere have an increasing distance in the direction to the optical axis. This double asphere opens toward the outside and defines a complex corrective means with average beam separation.

The lens L404 belongs already to the second lens group which includes the lenses L405 to L407. This second lens group has a negative refractive power.

The first lenses L402 to L405 have an especially low refractive power f_{L402} = 1397.664 mm, f_{L403} = 509.911 mm, f_{L404} = 1371.145 mm and f_{L405} = -342.044 mm. A further aspheric lens surface is provided at the image end on the lens L407.

The next lens group G3 has a positive refractive power and includes the lenses L408 to L413. The lens L409 has, at the object end, an aspheric lens surface and the lens L413 is provided with an aspheric lens surface at the image side. The aspheric lens L413 has a positive influence on the coma of higher order and on the 45° structures. The air space, which is provided between the lenses L411 and L412 is virtually equidistant.

The lens group G4 has a negative refractive power and is defined by the lenses L414 to L416. The lens L415 has an aspheric lens surface on the image side. This aspheric lens surface operates in a good mixture on aperture dependent and field dependent imaging errors, especially for objectives having a high aperture.

The next lens group G5 is defined by the lenses L417 to L427. A diaphragm AP is mounted between the lenses L420 to L421. The lens surface of the lens L422, which follows the

diaphragm AP, has an aspheric form. With this aspheric lens, it is possible to carry out the correction of the spheric aberration without influencing other imaging errors. For this purpose, it is, however, necessary with the presence of a clear diaphragm curvature, that the aspheric surface projects into the region of a slide diaphragm.

Furthermore, the mutually adjacent lens surfaces of the lenses L423 and L424 (identified by AS3 and AS4) are made to have an aspheric form. With this follow-on double asphere, it is especially possible to have an excellent aplanar correction for highest numerical aperture. The simultaneous correction of the spheric aberration and the satisfaction of the sine condition is therefore possible.

The lens group G6 is configured by the lenses L428 to L429 which are configured as planar plates. It can, in turn, be provided that the intermediate space between the planar parallel plates 428 and 429 are chargeable with a fluid.

Quartz glass is provided as a lens material. To reduce the chromatic aberration, the lenses L408 and L409 as well as L413 can be made of calcium fluoride. To reduce the compaction effect because of the high radiation load, it can be provided that calcium fluoride be used as a material for the smaller one or for both planar parallel plates L428 and L429. It is noted that, in this projection objective, the maximum diameter of the lens group G3 has, with 398 mm, a greater maximum diameter than the lens group G5. This objective is very well corrected and the deviation from the wavefront of an ideal spherical wave is > = 1.2 mλ referred to 193 nm. The spacing between object plane 0 and image plane 0' is 1188.1 mm and the exposable field is 8x26 mm. The precise lens data are set forth in Table 4.

The projection objective shown in FIG. 6 includes the lens groups G1 to G6 with the lenses L501 to L530. Planar plates are provided for L529 and L530. This projection objective is designed for the wavelength 193 nm and has a numerical aperture of 0.9. The spacing between the object plane 0 and the image plane 0' is 1174.6 mm. The exposable field has a size of 8x26 mm. Viewed macroscopically, this projection objective does not differ from the projection objective shown in FIG. 5. Again, especially the lenses L502 and L503 have a low refractive power. The lens L510 is provided especially for the quadratic correction.

Apart from the planar parallel plates L529 and L530, all lenses L501 to L528 are of quartz glass. This projection objective too is very well corrected and the deviation from the ideal wavefront of a spherical wave is < 3.0 mλ referred to 193 nm. The lenses L510, L515, L522 have a low refractive power. The precise lens data are set forth in Table 5. The effect of the aspheric surfaces corresponds principally to the effects described with respect to FIG. 5. The effects are still greater because of the high numerical aperture of 0.9.

The projection objective shown in FIG. 7 for the wavelength 157 nm includes six lens groups having lenses L601 to L630 with planar parallel plates L629 and L630. The structural length of this projection objective from object plane 0 to image plane 0' is 997.8 mm. A field of 7x22 mm can be exposed. The numerical aperture of this objective is 0.9. Calcium fluoride is provided as a lens material. A further correction of chromatic errors is achievable with the use of barium fluoride as a lens material for the lenses L614 to L617. The deviation from the wavefront of an ideal spherical wave

is < 1.8 mλ referred to 157 nm. Viewed macroscopically, the configuration of the projection objective shown in FIG. 7 differs only slightly from the projection objective described with respect to FIGS. 5 and 6. For this reason, reference is made to the description with respect to FIG. 5. The exact lens data are set forth in Table 6.

The projection objective shown in FIG. 8 includes six lens groups G1 to G6. The first lens group includes the lenses L701 to L704. The lens L701 at the object side and the lens L704 at the image side have aspheric lens surfaces. This first lens group includes only lenses of positive refractive power which have approximately identical diameters.

The second lens group G2 follows and has a negative refractive power and includes the lenses L705 to L708. The lens L705 has an aspheric lens surface on the side facing toward lens L704 and this aspheric lens surface is identified by AS2. A double asphere 21 is formed by the two aspheric lens surfaces AS1 and AS2. This double asphere is curved toward the wafer and opens slightly in the radial direction. Furthermore, the lens L708 has an aspheric lens surface at the image end.

The third lens group G3 has lenses L709 to L714 and has a positive refractive power. This lens group includes two aspheric lenses L710 and L714. The air gap, which is formed between the lenses L712 and L713, has an almost constant thickness.

The fourth lens group G4 includes only two negative lenses L715 and L716 with which a restriction is formed. The lens L715 is provided at the image side with an aspherical lens surface.

The fifth lens group has lenses L717 to L727 and has a positive refractive power. The diaphragm AP is mounted between

the lenses L720 and L721. In this lens group, a further double asphere 21 is provided which is formed by the two aspheric lens surfaces AS3 and AS4 of the lenses L723 and L724. Further aspheric lens surfaces are on the lens L721 on the object side and on lens L727 on the image side.

The last lens group G6 follows this lens group and is defined by the two planar parallel plates L728 and L729. An intermediate space 25 is formed by the mutually adjacent surfaces of the planar plates L728 and L729. The intermediate space 25 can be charged with pressure.

This projection objective is designed for the wavelength 193 nm and has a numerical aperture of 0.9. The distance between object plane 0 and image plane 0' is 1209.6 mm. A field of 10.5x26 mm can be exposed with this projection objective. The maximum deviation from the ideal wavefront of a spherical wave is 3.0 mλ referred to 193 nm. This deviation is determined by means of the program code CODE V. The precise lens data are set forth in Table 7.

In FIG. 9, a catadioptric projection objective is shown which is designed for the wavelength 157 nm. A field of 22x7 mm can be exposed with this projection objective. The numerical aperture is 0.8. All lenses in this projection objective are made of calcium fluoride. The first lens L801 is provided with an aspheric lens surface on the image side. This aspheric lens supplies especially a valuable contribution to the correction of the distortion.

The radiation is deflected by mirror SP 1 and impinges on the lens L802 of negative refractive power. The next lens L803 is provided with an aspheric lens surface on the lens side on the image side in the beam path. This aspheric lens supplies an

especially valuable contribution to the correction of the spherical aberration.

The radiation, which propagates from lens L803, is reflected back at the mirror SP 2 and passes the lenses L803 and L802 in the opposite sequence before it is directed via reflection at mirror SP 3 to the lens L804 which is mounted on an optical axis common with the lens L801. An intermediate image Z1 arises between the mirror SP 3 and lens L804. The next lenses L805 and L806 have aspheric lens surfaces AS1 and AS2 on the mutually adjacent surfaces. A double asphere is formed by these aspheres. Furthermore, the objective includes the lenses L807 to L818. The lenses L812, L814, L816 and L818 are provided with aspheric surfaces on the image side and the lens L817 has an aspheric lens surface on the object side. A double asphere is formed by the aspheric lens surfaces of the lenses L816 and L817.

The subject matter of PCT/EP 00/13148, filed December 22, 2000, is incorporated herein by reference.

It is understood that the foregoing description is that of the preferred embodiments of the invention and that various changes and modifications may be made thereto without departing from the spirit and scope of the invention as defined in the appended claims.

TABLE 1

M1197a

LENSES	RADII	THICKNESSES	GLASSES	REFRACTIVE INDEX AT 157 nm	1/2 FREE DIAMETER
0	infinite	32.000000000	N2	1.00000320	54.410
	infinite	3.386300000	N2	1.00000320	61.189
L101	331.163350000	17.963900000	CaF2	1.55840983	63.195
	-319.616060000	1.476400000	N2	1.00000320	63.531
L102	766.337390000	17.162600000	CaF2	1.55840983	63.346
	-447.357070000	0.750000000	N2	1.00000320	62.932
L103	308.080750000	26.167800000	CaF2	1.55840983	61.274
	-256.921560000AS	0.781900000	N2	1.00000320	59.279
104	-199.459070000AS	7.000000000	CaF2	1.55840983	59.017
	115.459900000	26.055700000	N2	1.00000320	53.978
L105	-155.555940000	7.000000000	CaF2	1.55840983	54.017
	181.538670000	32.685400000	N2	1.00000320	57.637
L106	-105.047550000	7.623100000	CaF2	1.55840983	59.819
	-6182.626690000AS	16.767300000	N2	1.00000320	74.788
L107	-441.263450000	27.098000000	CaF2	1.55840983	83.940
	-151.990780000	2.318200000	N2	1.00000320	88.568
L108	-613.725250000	45.372400000	CaF2	1.55840983	103.501
	-150.623730000	2.560000000	N2	1.00000320	107.663
L109	1648.391330000	42.538400000	CaF2	1.55840983	119.260
	-255.166800000	2.852600000	N2	1.00000320	120.183
L110	154.432580000	47.915200000	CaF2	1.55840983	110.475
	1162.400830000	0.929300000	N2	1.00000320	107.883
L111	261.100680000	20.383600000	CaF2	1.55840983	98.431
	614.726380000AS	0.867900000	N2	1.00000320	93.917
L112	359.575500000	7.168800000	CaF2	1.55840983	89.668
	126.930570000	40.754900000	N2	1.00000320	76.782
L113	-253.190760000	7.000000000	NAF	1.46483148	74.969
	132.038930000	28.180300000	N2	1.00000320	67.606
L114	-338.990070000	7.611900000	NAF	1.46483148	67.535
	222.374240000	39.202700000	N2	1.00000320	68.722
L115	-109.896940000	7.095700000	NAF	1.46483148	69.544
	705.107390000	19.428900000	N2	1.00000320	84.312
L116	-706.158480000	29.677100000	LIF	1.47810153	90.890
	-180.715990000	5.740400000	N2	1.00000320	95.248
L117	1725.475600000	35.904100000	LIF	1.47810153	112.495
	-263.017160000	0.750000000	N2	1.00000320	114.191
L118	619.827930000	64.044600000	LIF	1.47810153	121.296
	-197.026470000	0.750100000	N2	1.00000320	121.844
L119	-195.861770000	7.000000000	NAF	1.46483148	121.626
	-469.620100000	0.750000000	N2	1.00000320	123.300
	infinite	0.750600000	N2	1.00000320	122.405
L120	640.893310000	25.458500000	LIF	1.47810153	123.549
	-1089.937900000	0.980400000	N2	1.00000320	123.525
L121	322.108140000	34.102200000	LIF	1.47810153	121.602
	-1728.500990000	31.928200000	N2	1.00000320	120.573
L122	-234.494140000	46.273400000	CaF2	1.55840983	119.587
	-251.236960000	0.974700000	N2	1.00000320	121.785
L123	171.211410000	29.502800000	LIF	1.47810153	103.953
	452.301450000	0.887100000	N2	1.00000320	101.542
L124	126.180740000	28.831400000	LIF	1.47810153	88.565
	223.894010000	0.796800000	N2	1.00000320	83.098
L125	132.333150000	25.819300000	LIF	1.47810153	76.140
	477.745080000	6.457300000	N2	1.00000320	70.847
L126	infinite	59.682500000	CaF2	1.55840983	69.261
	infinite	0.838600000	N2	1.00000320	33.343
L127	infinite	4.000000000	CaF2	1.55840983	32.211
	infinite	12.000810000	N2	1.00000320	29.804
L128	infinite	0.000000000			13.603

ASPHERIC CONSTANTS

Asphere of Lens L103

K	-0.8141
C1	-1.93290250e-007
C2	4.16659320e-011
C3	-4.77885250e-015
C4	3.28605790e-019
C5	-1.03537910e-022
C6	2.39743010e-026
C7	0.00000000e+000
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L104

K	-1.0887
C1	1.57414760e-008
C2	1.63099500e-011
C3	-4.85048550e-015
C4	9.48501060e-019
C5	-2.37918310e-022
C6	3.60692700e-026
C7	0.00000000e+000
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L106

K	4235.0115
C1	1.16160120e-007
C2	-1.37360280e-011
C3	-1.75181710e-016
C4	1.56917750e-019
C5	-1.57135270e-023
C6	5.89614270e-028
C7	0.00000000e+000
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L111

K	0.0000
C1	1.35782560e-009
C2	-2.31506660e-013
C3	2.14831120e-017
C4	-7.84495330e-022
C5	-4.23732680e-026
C6	1.17366430e-031
C7	0.00000000e+000
C8	0.00000000e+000
C9	0.00000000e+000

Refractive index and wavelength are referred to air.

TABLE 2

M1159a

LENSES	RADII	THICKNESSES	GLASSES	REFRACTIVE INDEX AT 248.38 nm	1/2 FREE DIAMETER
0	infinite	32.000000000	Luft	0.99998200	54.410
	infinite	0.750000000	Luft	0.99998200	61.498
L201	359.203085922	16.544139898	SIO2	1.50837298	62.894
	-367.814285018	0.750000000	Luft	0.99998200	63.342
L202	376.906582229	16.424149202	SIO2	1.50837298	63.744
	-370.266896435	0.750000000	Luft	0.99998200	63.552
L203	623.868133301	12.000921336	SIO2	1.50837298	62.201
	-558.943539628	4.488271401	Luft	0.99998200	61.489
L204	-593.881163796	10.597937240	SIO2	1.50837298	60.233
	-258.275165583AS	1.300130829	Luft	0.99998200	59.503
L205	-195.528496730AS	7.000000000	SIO2	1.50837298	59.067
	114.970814112	27.465616009	Luft	0.99998200	54.855
L206	-150.593037892	7.000000000	SIO2	1.50837298	55.023
	203.788990073	29.227930343	Luft	0.99998200	59.359
L207	-116.847756998	7.000000015	SIO2	1.50837298	60.888
	-1029423.850607139AS	26.431412586	Luft	0.99998200	74.043
L208	-433.333706324	29.900058462	SIO2	1.50837298	89.733
	-145.855178517	0.750000000	Luft	0.99998200	93.351
L209	-740.439232493AS	44.983538148	SIO2	1.50837298	108.655
	-155.998681446	0.750000000	Luft	0.99998200	111.280
L210	730.369450038	38.596890643	SIO2	1.50837298	120.834
	-339.830855552	0.750000000	Luft	0.99998200	121.150
L211	159.417768241	52.577878183	SIO2	1.50837298	112.765
	457732.591606731AS	0.780542469	Luft	0.99998200	110.299
L212	190.812012094	23.738591831	SIO2	1.50837298	94.787
	115.677643950	40.245663292	Luft	0.99998200	77.717
L213	-412.140976525	7.000000000	SIO2	1.50837298	76.256
	151.701098214	27.102188582	Luft	0.99998200	69.619
L214	-319.487543080	7.000000000	SIO2	1.50837298	69.443
	236.707933198	42.112032397	Luft	0.99998200	70.193
L215	-105.934259216	8.769693914	SIO2	1.50837298	71.068
	680.231460994	17.681829203	Luft	0.99998200	88.650
L216	-517.056865132	36.235608441	SIO2	1.50837298	91.923
	-185.271735391	0.764865888	Luft	0.99998200	100.651
L217	2262.402798068	44.431825566	SIO2	1.50837298	119.658
	-267.329724617	8.198939895	Luft	0.99998200	123.247
L218	1103.186796189	40.827914599	SIO2	1.50837298	133.839
	-364.593909045	8.280602730	Luft	0.99998200	134.570
	infinite	-3.250000000	Luft	0.99998200	133.180
L219	620.770366318	25.036239346	SIO2	1.50837298	134.241
	-1858.943929157	0.750000000	Luft	0.99998200	134.164
L220	329.635686681	40.854820783	SIO2	1.50837298	132.227
	-1181.581276955	31.972595866	Luft	0.99998200	131.156
L221	-249.799136729	10.000000000	SIO2	1.50837298	130.229
	6484.262988004	5.619260320	Luft	0.99998200	130.672
L222	-2574.687141000	38.775298966	SIO2	1.50837298	130.696
	-254.665255526	0.750000000	Luft	0.99998200	130.891
L223	203.341746230	25.409827006	SIO2	1.50837298	110.728
	463.496973555	0.750000000	Luft	0.99998200	108.517
L224	118.263098967	37.247858671	SIO2	1.50837298	92.529
	191.067427473	0.753637388	Luft	0.99998200	84.037
L225	137.671384625	24.859589811	SIO2	1.50837298	78.934
	507.533271700	6.693359054	Luft	0.99998200	74.624
L226	infinite	55.768369688	SIO2	1.50837298	72.833
	infinite	0.800000000	Luft	0.99998200	35.729
L227	infinite	4.000000000	SIO2	1.50837298	34.512
	infinite	11.999970000	Luft	0.99998200	31.851
L228	infinite	0.000000000		1.00000000	13.602

ASPHERIC CONSTANTS

Asphere of Lens L204

K	-0.7780
C1	-1.91000417e-007
C2	4.02870297e-011
C3	-5.55434626e-015
C4	1.68245178e-019
C5	2.20604311e-023
C6	8.09599744e-027
C7	0.00000000e+000
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L205

K	-0.4166
C1	5.25344324e-008
C2	1.26756433e-011
C3	-5.25489404e-015
C4	7.04023970e-019
C5	-1.04520766e-022
C6	2.06454806e-026
C7	0.00000000e+000
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L207

K	-2116959451.7820
C1	1.25171476e-007
C2	-1.53794245e-011
C3	-3.12532578e-016
C4	2.00967035e-019
C5	-2.05026124e-023
C6	7.81326379e-028
C7	0.00000000e+000
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L211

K	0.0000
C1	2.78321477e-009
C2	5.89866335e-014
C3	1.19811527e-017
C4	-7.81165149e-022
C5	1.66111023e-026
C6	-1.60965484e-031
C7	0.00000000e+000
C8	0.00000000e+000
C9	0.00000000e+000

Refractive index and wavelength were determined in air.

TABLE 3

M1222a

LENSES	RADII	THICKNESSES	GLASSES	REFRACTIVE INDEX AT 248.380nm	1/2 FREE DIAMETER
0	infinite	32.000000000	L710		54.410
	infinite	0.750000000	L710		62.206
L301	12444.588054076	17.524945114	SIO2	1.50837298	62.427
	-167.739069307	0.765384867	L710	0.99998200	63.213
L302	1202.845295516	8.943027554	SIO2	1.50837298	63.724
	-1004.036633539	0.757676170	L710	0.99998200	63.750
L303	235.865591780	9.298971429	SIO2	1.50837298	63.464
	231.568686620	24.888929767	L710	0.99998200	62.457
L304	-148.910928631	11.307968350	SIO2	1.50837298	62.393
	-106.056725042AS	11.531057240	L710	0.99998200	63.087
L305	-135.467082619AS	7.000000000	SIO2	1.50837298	60.496
	236.063635384	11.820516442	L710	0.99998200	61.104
L306	-1613.154189634	7.000000000	SIO2	1.50837298	61.565
	222.732790977	38.103480975	L710	0.99998200	63.842
L307	-93.477889742	7.004909948	SIO2	1.50837298	64.855
	10625258.126273967AS	25.183324680	L710	0.99998200	84.949
L308	-313.395232213	37.921288357	SIO2	1.50837298	94.853
	-140.728421777	2.422311655	L710	0.99998200	102.129
L309	-882.714069478AS	62.983288381	SIO2	1.50837298	129.319
	-162.454752849	0.750000000	L710	0.99998200	131.820
L310	372.954030958	61.566328910	SIO2	1.50837298	148.956
	-446.221051696	0.750000000	L710	0.99998200	148.766
L311	159.626550846	68.423222152	SIO2	1.50837298	126.219
	6881.817080351AS	0.754846049	L710	0.99998200	121.302
L312	1035.238560782	11.490813397	SIO2	1.50837298	116.908
	181.491627420	22.008897360	L710	0.99998200	97.838
L313	508.638145894	7.024491847	SIO2	1.50837298	96.444
	144.727315074	42.480962349	L710	0.99998200	85.818
L314	-315.769132147	7.000000000	SIO2	1.50837298	85.132
	168.042488686AS	60.840114041	L710	0.99998200	82.384
L315	-110.641058959	7.000000000	SIO2	1.50837298	82.821
	460.993264759	26.383956624	L710	0.99998200	108.073
L316	-573.887503383	33.664255268	SIO2	1.50837298	111.503
	-189.203245467	0.750000000	L710	0.99998200	115.508
L317	-4374.531790288	33.200388364	SIO2	1.50837298	144.129
	-365.840916872	0.750000000	L710	0.99998200	146.400
L318	5367.437754044	32.001020330	SIO2	1.50837298	162.024
	-556.194479444	0.857496674	L710	0.99998200	163.414
L319	1425.923295786	68.540751990	SIO2	1.50837298	172.847
	-318.608860176	8.280602730	L710	0.99998200	173.674
	infinite	-3.250000000	L710	0.99998200	165.236
L320	524.088279104	18.000000000	SIO2	1.50837298	164.278
	896.107746530	0.750000000	L710	0.99998200	163.371
L321	447.468508944	50.493798307	SIO2	1.50837298	161.574
	-849.886554129	37.700767601	L710	0.99998200	160.560
L322	-277.232722440	15.000000000	SIO2	1.50837298	159.396
	-359.067701243AS	13.800352685	L710	0.99998200	159.582
L323	-283.705002828AS	20.143173981	SIO2	1.50837298	158.903
	-264.293409160	0.750000000	L710	0.99998200	159.923
L324	182.924856302	28.086938401	SIO2	1.50837298	124.917
	293.542915952	0.750000000	L710	0.99998200	122.142
L325	138.051507251	29.667601165	SIO2	1.50837298	107.973
	206.495592035	4.518697859	L710	0.99998200	103.815
L326	137.608373914	37.703252491	SIO2	1.50837298	93.164
	2008.206929102AS	6.230615100	L710	0.99998200	88.838
L327	79833.713358573	27.734587521	SIO2	1.50837298	83.516
	infinite	5.000000000	L710	0.99998200	62.961
L328	infinite	25.000000000	SIO2	1.50837298	52.694
	infinite	10.000000000	L710	0.99998200	34.137
L329	infinite	0.000000000			13.605

L710 = Air at 710 Torr

ASPHERIC CONSTANTS

Asphere of Lens L304

K	-1.5058
C1	-1.86740544e-007
C2	3.71500406e-011
C3	-8.38153156e-015
C4	1.06034402e-018
C5	-7.88993246e-023
C6	2.81358334e-027
C7	0.00000000e+000
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L305

K	-1.3497
C1	9.59200710e-008
C2	3.31187872e-011
C3	-1.02270060e-014
C4	1.45048880e-018
C5	-1.18276835e-022
C6	5.49446108e-027
C7	0.00000000e+000
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L307

K	-2342767185776735500000000000.0000
C1	1.13856265e-007
C2	-9.18910043e-012
C3	-2.09482944e-016
C4	8.75414269e-020
C5	-6.71659158e-024
C6	1.94896163e-028
C7	0.00000000e+000
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L311

K	0.0000
C1	1.36987424e-008
C2	-6.69820602e-013
C3	2.24912373e-017
C4	-5.16548278e-022
C5	4.05832389e-027
C6	3.25008659e-032
C7	0.00000000e+000
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L314

K	0.0000
C1	-3.81602557e-009
C2	-1.32998252e-012
C3	0.00000000e+000
C4	-3.24422613e-021
C5	3.55600124e-025
C6	-2.11130790e-029
C7	0.00000000e+000
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L322

K	0.0000
C1	2.20018047e-011
C2	-6.06720907e-016
C3	-1.85544385e-019
C4	1.99332533e-023
C5	-1.25615823e-028
C6	5.72017494e-033
C7	0.00000000e+000
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L323

K	0.0000
C1	2.59747415e-011
C2	1.15845870e-015
C3	2.93792021e-019
C4	-5.20753147e-024
C5	5.15087863e-028
C6	-3.68361393e-033
C7	0.00000000e+000
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L326

K	0.0000
C1	2.53574810e-008
C2	1.14136997e-012
C3	-2.09898773e-016
C4	1.80771983e-020
C5	-8.70458993e-025
C6	1.83743606e-029
C7	0.00000000e+000
C8	0.00000000e+000
C9	0.00000000e+000

M1450a

TABLE 4

LENSES	RADII	THICKNESSES	GLASSES	REFRACTIVE INDEX AT 193.304nm	1/2 FREE DIAMETER
0	infinite	32.000000000	L710	0.99998200	54.410
	infinite	0.700000000	L710	0.99998200	61.369
L401	1072.135967906AS	17.638366552	SIO2	1.56028895	62.176
	-274.850778792	10.038841436	HE	0.99971200	62.804
L402	-195.160258125	9.677862773	SIO2	1.56028895	62.822
	-159.034954419	15.411706951	HE	0.99971200	63.649
L403	-409.040910955	11.634800854	SIO2	1.56028895	62.424
	-184.929247238	18.878098976	HE	0.99971200	62.549
L404	-86.928681017	9.000000000	SIO2	1.56028895	61.870
	-81.003682870AS	3.559685814	HE	0.99971200	63.469
L405	-105.055795110AS	6.000000000	SIO2	1.56028895	60.375
	-237.059668556	7.135710642	HE	0.99971200	61.325
L406	-170.390902140	6.000000000	SIO2	1.56028895	61.152
	179.617978310	40.187039625	HE	0.99971200	64.312
L407	-108.910057000	6.000000000	SIO2	1.56028895	66.769
	10000.000000000AS	23.032466424	HE	0.99971200	84.010
L408	-482.423484275	35.657870541	SIO2	1.56028895	98.271
	-166.024534852	0.712083613	HE	0.99971200	104.636
L409	-5301.825985682AS	59.184134830	SIO2	1.56028895	129.868
	-219.603781546	1.964238192	HE	0.99971200	135.616
L410	-407.514819861	25.000000000	SIO2	1.56028895	141.192
	-275.650807138	2.073256156	HE	0.99971200	143.933
L411	812.482278880	41.728126549	SIO2	1.56028895	150.437
	2085.321083022	11.867512800	HE	0.99971200	150.588
L412	1989.395979432	66.189720990	SIO2	1.56028895	151.170
	-336.825131023	2.208063283	HE	0.99971200	151.249
L413	161.751335222	66.140524993	SIO2	1.56028895	121.860
	-7743.125302019AS	0.732008617	HE	0.99971200	115.257
L414	2700.830058670	8.000000000	SIO2	1.56028895	112.928
	175.482298866	18.681794864	HE	0.99971200	94.204
L415	330.479176880	8.000000000	SIO2	1.56028895	91.933
	215.492418517	37.734500801	HE	0.99971200	86.259
L416	-263.077268094	6.000000000	SIO2	1.56028895	83.596
	119.453498304AS	66.406324570	HE	0.99971200	77.915
L417	-126.431526615	6.000000000	SIO2	1.56028895	80.395
	1627.715124622	24.178532080	HE	0.99971200	96.410
L418	-517.066851877	30.987035837	SIO2	1.56028895	105.371
	-242.666474401	0.700000000	HE	0.99971200	113.249
L419	-737.673536297	30.292644418	SIO2	1.56028895	124.350
	-270.925750340	0.700000000	HE	0.99971200	128.112
L420	-1051.979110054	27.301344542	SIO2	1.56028895	137.231
	-363.545320262	0.711035404	HE	0.99971200	139.644
L421	914.456821676	50.497126159	SIO2	1.56028895	148.531
	-500.741001160	10.000000000	HE	0.99971200	149.700
L422	infinite	-5.000000000	HE	0.99971200	146.693
	353.826401507AS	22.748234242	SIO2	1.56028895	147.721
L423	529.864238000	1.376970242	HE	0.99971200	146.294
	422.718681400	57.709521396	SIO2	1.56028895	146.003
L424	-733.506899438	37.321473463	HE	0.99971200	143.238
	-261.264462802	15.000000000	SIO2	1.56028895	138.711
L425	-292.145870649AS	18.942285163	HE	0.99971200	139.089
	-225.638240671AS	19.098948274	SIO2	1.56028895	136.464
L426	-230.537827019	0.700000000	HE	0.99971200	138.299
	246.284141218	23.038665896	SIO2	1.56028895	114.892
L427	400.381469987	0.704537226	HE	0.99971200	110.931
	131.458744675	28.653621426	SIO2	1.56028895	98.090
L428	200.500973816	0.708148286	HE	0.99971200	93.130
	139.428371855	36.540725215	SIO2	1.56028895	87.103
L429	1188.104646109AS	8.107454155	HE	0.99971200	79.764
	infinite	25.934594077	CaF2	1.50143563	72.791
L430	infinite	5.000000000	L710	0.99998200	54.980
	infinite	25.000000000	CAF2HL	1.50143563	46.911
L431	infinite	10.000000000	L710	0.99998200	29.741
	infinite	0.000000000			13.603

L710 = Air at 710 Torr

ASPHERIC CONSTANTS

Asphere of Lens L401

K	0.0000
C1	7.64628377e-008
C2	6.87967706e-013
C3	6.32367166e-017
C4	4.65534082e-020
C5	-1.74760583e-023
C6	3.25143184e-027
C7	-2.97366674e-031
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L404

K	-1.3306
C1	-2.46704917e-007
C2	1.00943626e-011
C3	-6.88338440e-015
C4	1.00927351e-018
C5	-1.37371749e-022
C6	9.94732480e-027
C7	-6.46127195e-031
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L405

K	-1.1682
C1	8.44108642e-008
C2	6.67934072e-012
C3	-5.16053049e-015
C4	8.51835178e-019
C5	-9.37525700e-023
C6	3.80738193e-027
C7	-7.58518933e-035
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L407

K	0.0000
C1	8.18369639e-008
C2	-9.75131236e-012
C3	3.85197305e-016
C4	1.05024918e-020
C5	-3.84907914e-024
C6	3.28329458e-028
C7	-1.16692413e-032
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L409

K	0.0000
C1	4.21547093e-009
C2	-2.05810358e-013
C3	-2.19266732e-018
C4	-7.83959176e-023
C5	6.55613544e-027
C6	-7.33103571e-032
C7	-2.15461419e-036
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L413

K	0.0000
C1	1.39800416e-008
C2	-1.91505190e-013
C3	-1.26782008e-017
C4	9.93778200e-022
C5	-5.55824342e-026
C6	1.85230750e-030
C7	-2.83026055e-035
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L416

K	0.0000
C1	-1.87949694e-008
C2	-4.87119675e-012
C3	-5.90009367e-017
C4	-5.76749530e-021
C5	-3.07189672e-025
C6	4.51160541e-029
C7	-5.02037364e-033
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L421

K	-0.0073
C1	1.63581145e-010
C2	-7.80915457e-015
C3	6.72460331e-021
C4	5.33479719e-025
C5	2.82144185e-028
C6	-6.16219372e-033
C7	2.37157562e-037
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L424

K	0.0000
C1	1.28367898e-010
C2	-1.18938455e-014
C3	-1.84714219e-019
C4	4.28587779e-023
C5	-1.39213579e-027
C6	2.04883718e-032
C7	-3.36201584e-037
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L425

K	0.0000
C1	-2.31584329e-010
C2	2.47013162e-014
C3	1.13928751e-018
C4	-1.24997826e-023
C5	-9.59653919e-028
C6	1.46403755e-032
C7	-1.23684921e-037
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L428

K	0.0000
C1	2.79193914e-008
C2	5.72325985e-013
C3	-1.69156262e-016
C4	1.45062961e-020
C5	-7.24157687e-025
C6	1.59130857e-029
C7	9.07975701e-035
C8	0.00000000e+000
C9	0.00000000e+000

M1558a

TABLE 5

LENSES	RADII	THICKNESSES	GLASSES	EFRACTIVE INDEX AT 193.304nm	1/2 FREE DIAMETER
0	infinite	32.000000000	L710	0.99998200	54.410
	infinite	0.700000000	L710	0.99998200	61.800
L501	1062.826934956AS	17.734965551	SIO2	1.56028895	62.680
	-280.649155373	9.921059017	HE	0.99971200	63.358
L502	-198.612797944	9.733545477	SIO2	1.56028895	63.454
	-157.546275141	15.417407860	HE	0.99971200	64.281
L503	-400.277413338	11.803054495	SIO2	1.56028895	63.163
	-182.515287485	19.059582585	HE	0.99971200	63.316
L504	-86.486413985	9.000000000	SIO2	1.56028895	62.723
	-79.976798205AS	3.314115561	HE	0.99971200	64.356
L505	-102.262183494AS	6.000000000	SIO2	1.56028895	61.260
	-275.242312561	7.844485351	HE	0.99971200	62.494
L506	-191.274205909	6.000000000	SIO2	1.56028895	62.450
	180.723494008	40.175681177	HE	0.99971200	65.811
L507	-108.539011643	6.000000000	SIO2	1.56028895	67.752
	10000.000000000AS	23.009626916	HE	0.99971200	86.379
L508	-481.040730284	35.657298256	SIO2	1.56028895	100.931
	-165.828518942	0.700000000	HE	0.99971200	106.719
L509	-5243.952853546AS	59.233771719	SIO2	1.56028895	134.666
	-218.541408733	2.123657562	HE	0.99971200	139.441
L510	-402.136827778	25.000000000	SIO2	1.56028895	145.856
	-276.854279724	1.637353303	HE	0.99971200	148.618
L511	796.304534481	36.805305429	SIO2	1.56028895	156.741
	2360.950907095	10.808883416	HE	0.99971200	157.059
L512	2256.926430541	60.789786196	SIO2	1.56028895	157.684
	-336.450738373	0.801676910	HE	0.99971200	157.856
L513	161.617552542	66.152351274	SIO2	1.56028895	125.624
	-6835.350709889AS	0.744366824	HE	0.99971200	121.362
L514	2851.162473443	8.000000000	SIO2	1.56028895	118.726
	173.208226906	18.750820117	HE	0.99971200	97.559
L515	318.351302869	8.000000000	SIO2	1.56028895	95.703
	214.643166184	38.151364608	HE	0.99971200	89.760
L516	-261.549915460	6.000000000	SIO2	1.56028895	88.331
	119.510683982AS	66.550546342	HE	0.99971200	82.116
L517	-126.322271364	6.000000000	SIO2	1.56028895	83.464
	1722.207555551	24.185704173	HE	0.99971200	102.415
L518	-506.819064828	30.988960270	SIO2	1.56028895	111.113
	-242.042046428	0.700000000	HE	0.99971200	118.861
L519	-728.789614455	30.297084361	SIO2	1.56028895	132.704
	-269.518093553	0.700000000	HE	0.99971200	135.576
L520	-1024.754284774	27.306923440	SIO2	1.56028895	147.201
	-361.037355343	0.700000000	HE	0.99971200	149.061
L521	929.096482269	49.082091976	SIO2	1.56028895	161.109
	-497.886578908	15.000000000	HE	0.99971200	161.854
	infinite	-10.000000000	HE	0.99971200	158.597
L522	352.973470359AS	22.735479730	SIO2	1.56028895	159.957
	529.864238000	1.119499649	HE	0.99971200	158.688
L523	422.718681400	57.532074113	SIO2	1.56028895	158.278
	-733.230538894	37.317449332	HE	0.99971200	156.533
L524	-261.165349728	15.000000000	SIO2	1.56028895	155.119
	-292.119447959AS	18.962883498	HE	0.99971200	156.043
L525	-226.263316842AS	19.009003051	SIO2	1.56028895	155.000
	-231.163516914	0.700000000	HE	0.99971200	157.710
L526	245.306778718	23.024380018	SIO2	1.56028895	124.547
	403.694577141	0.700000000	HE	0.99971200	121.262
L527	132.188567375	28.647981266	SIO2	1.56028895	104.696
	199.679919884	0.700019350	HE	0.99971200	101.254
L528	138.967602414	36.537553325	SIO2	1.56028895	93.617
	1194.093826692AS	8.108769689	HE	0.99971200	89.148
L529	infinite	25.923824338	CaF2	1.50143563	82.715
	infinite	5.000000000	L710	0.99998200	63.301
L530	infinite	25.000000000	CaF2	1.50143563	52.976
	infinite	10.000000000	L710	0.99998200	34.253
L531	infinite	0.000000000			13.603

L710 = Air at 710 Torr

ASPHERIC CONSTANTS

Asphere of Lens L501

K	0.0000
C1	7.79889739e-008
C2	5.96475035e-013
C3	5.73397945e-017
C4	5.38600405e-020
C5	-2.08145188e-023
C6	4.05094979e-027
C7	-3.79132983e-031
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L504

K	-1.3308
C1	-2.46633450e-007
C2	1.00446806e-011
C3	-7.00686898e-015
C4	9.90840734e-019
C5	-1.31781718e-022
C6	9.28901869e-027
C7	-6.52628587e-031
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L505

K	-1.1513
C1	8.27765089e-008
C2	7.00992841e-012
C3	-5.19825762e-015
C4	8.12467102e-019
C5	-8.31805913e-023
C6	2.18925711e-027
C7	1.11778799e-031
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L507

K	0.0000
C1	8.22829380e-008
C2	-9.72735758e-012
C3	3.85643753e-016
C4	1.01114314e-020
C5	-3.91221853e-024
C6	3.39732781e-028
C7	-1.20135313e-032
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L509

K	0.0000
C1	4.14637283e-009
C2	-2.13253257e-013
C3	-2.08003643e-018
C4	-7.83152213e-023
C5	5.30015388e-027
C6	-2.59321154e-033
C7	-3.37000758e-036
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L513

K	0.0000
C1	1.39567662e-008
C2	-2.05760928e-013
C3	-1.29919990e-017
C4	1.00302455e-021
C5	-5.58828742e-026
C6	1.79594589e-030
C7	-2.49374487e-035
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L516

K	0.0000
C1	-1.82058286e-008
C2	-4.87410470e-012
C3	-5.89919068e-017
C4	-4.04061992e-021
C5	-6.60202054e-025
C6	9.31855676e-029
C7	-7.48573635e-033
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L522

K	-0.0071
C1	1.64455895e-010
C2	-7.76483415e-015
C3	8.29256873e-021
C4	-5.46990406e-025
C5	3.42070772e-028
C6	-8.24545949e-033
C7	2.57783363e-037
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L524

K	0.0000
C1	1.18780021e-010
C2	-1.18823445e-014
C3	-1.80162246e-019
C4	4.08343213e-023
C5	-1.42735407e-027
C6	2.34804331e-032
C7	-3.79018523e-037
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L525

K	0.0000
C1	-2.15560895e-010
C2	2.44929281e-014
C3	1.12359306e-018
C4	-1.29749910e-023
C5	-1.00106399e-027
C6	1.88165471e-032
C7	-2.01557723e-037
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L528

K	0.0000
C1	2.73896476e-008
C2	6.17281255e-013
C3	-1.75474902e-016
C4	1.56329449e-020
C5	-8.82259694e-025
C6	2.92948124e-029
C7	-4.01055770e-034
C8	0.00000000e+000
C9	0.00000000e+000

M1587a

TABLE 6

LENSES	RADII	THICKNESSES	GLASSES	REFRACTIVE INDEX AT 157.629nm	1/2 FREE DIAMETER
0	infinite	27.171475840	N2	1.00031429	46.200
	infinite	0.602670797	N2	1.00031429	52.673
L601	900.198243311AS	15.151284556	CaF2	1.55929035	53.454
	-235.121108435	9.531971079	N2	1.00031429	54.049
L602	-167.185917779	8.294716452	CaF2	1.55929035	54.178
	-132.673519510	14.020355779	N2	1.00031429	54.901
L603	-333.194588652	9.893809820	CaF2	1.55929035	53.988
	-155.450516203	15.930502944	N2	1.00031429	54.132
L604	-73.572316296	7.641977580	CaF2	1.55929035	53.748
	-68.248613899AS	2.881720302	N2	1.00031429	55.167
L605	-86.993585564AS	5.094651720	CaF2	1.55929035	52.580
	-238.150965327	5.379130780	N2	1.00031429	53.729
L606	-165.613920870	5.094651720	CaF2	1.55929035	53.730
	153.417884485	34.150169591	N2	1.00031429	56.762
L607	-92.061009990	5.094651720	CaF2	1.55929035	58.081
	8491.086261873AS	19.673523795	N2	1.00031429	74.689
L608	-407.131300451	30.380807138	CaF2	1.55929035	87.291
	-140.620317156	0.761662684	N2	1.00031429	91.858
L609	-4831.804853654AS	50.269660218	CaF2	1.55929035	117.436
	-192.197373609	1.688916911	N2	1.00031429	121.408
L610	-367.718684892	21.227715500	CaF2	1.55929035	127.704
	-233.628547894	2.224071019	N2	1.00031429	129.305
L611	709.585855080	28.736922725	CaF2	1.55929035	137.016
	1238.859445357	9.120684720	N2	1.00031429	137.428
L612	1205.457051945	49.281218258	CaF2	1.55929035	138.288
	-285.321880705	1.625271224	N2	1.00031429	138.379
L613	137.549591710	56.718543740	CaF2	1.55929035	108.652
	-4380.301012978AS	0.623523902	N2	1.00031429	106.138
L614	2663.880214408	6.792868960	CaF2	1.55929035	103.602
	149.184979730	15.779049257	N2	1.00031429	84.589
L615	281.093108064	6.792868960	CaF2	1.55929035	83.373
	184.030288413	32.341552355	N2	1.00031429	77.968
L616	-222.157416308	5.094651720	CaF2	1.55929035	77.463
	101.254238115AS	56.792834221	N2	1.00031429	71.826
L617	-106.980638018	5.094651720	CaF2	1.55929035	72.237
	1612.305471130	20.581065398	N2	1.00031429	89.760
L618	-415.596135628	26.398111993	CaF2	1.55929035	96.803
	-204.680044631	0.713343960	N2	1.00031429	103.409
L619	-646.696622394	25.867340760	CaF2	1.55929035	116.636
	-231.917626896	0.766268682	N2	1.00031429	118.569
L620	-790.657607677	23.400482872	CaF2	1.55929035	128.806
	-294.872053725	0.721402031	N2	1.00031429	130.074
L621	786.625567756	40.932308205	CaF2	1.55929035	141.705
	-431.247283013	12.736629300	N2	1.00031429	142.089
	infinite	-8.491086200	N2	1.00031429	134.586
L622	295.022653593AS	20.185109438	CaF2	1.55929035	139.341
	449.912291916	0.619840486	N2	1.00031429	137.916
L623	358.934076212	48.662890509	CaF2	1.55929035	136.936
	-622.662988878	30.955714157	N2	1.00031429	135.288
L624	-224.404889753	12.736629300	CaF2	1.55929035	134.760
	-251.154571510AS	16.079850229	N2	1.00031429	134.853
L625	-193.582989843AS	16.510083506	CaF2	1.55929035	134.101
	-198.077570749	0.880353872	N2	1.00031429	136.109
L626	206.241795157	19.927993542	CaF2	1.55929035	101.240
	338.140581666	0.925956949	N2	1.00031429	97.594
L627	111.017549581	24.580089962	CaF2	1.55929035	85.023
	169.576109839	0.777849447	N2	1.00031429	81.164
L628	117.982165264	31.161065630	CaF2	1.55929035	75.464
	921.219058213AS	6.934980174	N2	1.00031429	69.501
L629	infinite	22.260797322	CaF2	1.55929035	63.637
	infinite	4.245543100	N2	1.00031429	48.606
L630	infinite	21.227715500	CaF2	1.55929035	41.032
	infinite	8.491086200	N2	1.00031429	26.698
	infinite	0.000000000		1.00000000	11.550

Wavelength and refractive index are given referred to Vacuum.

ASPHERIC CONSTANTS

Asphere of Lens L601

K	0.0000
C1	1.28594437e-007
C2	8.50731836e-013
C3	1.16375620e-016
C4	2.28674275e-019
C5	-1.23202729e-022
C6	3.32056239e-026
C7	-4.28323389e-030
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L604

K	-1.3312
C1	-4.03355456e-007
C2	2.25776586e-011
C3	-2.19259878e-014
C4	4.32573397e-018
C5	-7.92477159e-022
C6	7.57618874e-026
C7	-7.14962797e-030
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L605

K	-1.1417
C1	1.33637337e-007
C2	1.56787758e-011
C3	-1.64362484e-014
C4	3.59793786e-018
C5	-5.11312568e-022
C6	1.70636633e-026
C7	1.82384731e-030
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L607

K	0.0000
C1	1.34745120e-007
C2	-2.19807543e-011
C3	1.20275881e-015
C4	4.39597377e-020
C5	-2.37132819e-023
C6	2.87510939e-027
C7	-1.42065162e-031
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L609

K	0.0000
C1	6.85760526e-009
C2	-4.84524868e-013
C3	-6.28751350e-018
C4	-3.72607209e-022
C5	3.25276841e-026
C6	-4.05509974e-033
C7	-3.98843079e-035
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L613

K	0.0000
C1	2.24737416e-008
C2	-4.45043770e-013
C3	-4.10272049e-017
C4	4.31632628e-021
C5	-3.27538237e-025
C6	1.44053025e-029
C7	-2.76858490e-034
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L616

K	0.0000
C1	-2.83553693e-008
C2	-1.12122261e-011
C3	-2.05192812e-016
C4	-1.55525080e-020
C5	-4.77093112e-024
C6	8.39331135e-028
C7	-8.97313681e-032
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L622

K	0.0421
C1	7.07310826e-010
C2	-2.00157185e-014
C3	-9.33825109e-020
C4	1.27125854e-024
C5	1.94008709e-027
C6	-6.11989858e-032
C7	2.92367322e-036
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L624

K	0.0000
C1	3.02835805e-010
C2	-2.40484062e-014
C3	-3.22339189e-019
C4	1.64516979e-022
C5	-8.51268614e-027
C6	2.09276792e-031
C7	-4.74605669e-036
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L625

K	0.0000
C1	-3.99248993e-010
C2	5.79276562e-014
C3	3.53241478e-018
C4	-4.57872308e-023
C5	-6.29695208e-027
C6	1.57844931e-031
C7	-2.19266130e-036
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L628

K	0.0000
C1	4.40737732e-008
C2	1.52385268e-012
C3	-5.44510329e-016
C4	6.32549789e-020
C5	-4.58358203e-024
C6	1.92230388e-028
C7	-3.11311258e-033
C8	0.00000000e+000
C9	0.00000000e+000

M1630a

TABLE 7

LENSES	RADII	THICKNESSES	GLASSES	REFRACTIVE INDEX AT 193.304nm	1/2 FREE DIAMETER
0	infinite	32.989007360	L710	0.99998200	56.080
	infinite	2.050119724	L710	0.99998200	63.700
L701	1292.577885893AS	17.083079028	SIO2	1.56028895	64.846
	-320.912994055	6.356545111	HE	0.99971200	65.549
L702	-222.076099367	9.996105426	SIO2	1.56028895	65.651
	-173.186007383	14.918724377	HE	0.99971200	66.515
L703	-465.289541055	12.849128877	SIO2	1.56028895	65.892
	-190.575077708	24.825544140	HE	0.99971200	66.089
L704	-88.003869940	9.278158320	SIO2	1.56028895	64.773
	-80.342454766AS	3.110021891	HE	0.99971200	66.529
L705	-104.692897461AS	6.185438880	SIO2	1.56028895	63.593
	687.929853355	8.052826671	HE	0.99971200	65.986
L706	-4211.039282601	6.185438880	SIO2	1.56028895	66.833
	191.063416206	42.178241931	HE	0.99971200	69.389
L707	-115.620656932	6.185438880	SIO2	1.56028895	71.596
	10919.608812170AS	23.544585745	HE	0.99971200	91.649
L708	-462.245785462	36.857934334	SIO2	1.56028895	105.419
	-166.710127403	0.922637637	HE	0.99971200	110.921
L709	-2362.175430424AS	61.803635845	SIO2	1.56028895	140.744
	-209.701792909	1.020714627	HE	0.99971200	144.651
L710	-389.602200799	25.772662000	SIO2	1.56028895	151.693
	-307.008965979	0.721634536	HE	0.99971200	156.014
L711	629.229001456	46.511934207	SIO2	1.56028895	167.044
	-859.369679090	24.151857437	HE	0.99971200	167.077
L712	-877.205712077	30.754166393	SIO2	1.56028895	164.429
	-357.572652646	4.953800031	HE	0.99971200	164.440
L713	168.111512940	68.382989629	SIO2	1.56028895	129.450
	infinite	0.000000000	HE	0.99971200	125.021
L714	infinite	8.247251840	SIO2	1.56028895	125.021
	149.672876100AS	23.428435757	HE	0.99971200	98.364
L715	167.316121704	0.000000000	SIO2	1.56028895	92.117
	167.316121704	46.368104843	HE	0.99971200	92.117
L716	-276.014955570	6.185438880	SIO2	1.56028895	90.583
	122.032488640AS	68.057116286	HE	0.99971200	84.260
L717	-131.026926440	6.185438880	SIO2	1.56028895	85.665
	1443.442379280	24.936997937	HE	0.99971200	105.177
L718	-570.720178737	31.985422479	SIO2	1.56028895	114.725
	-251.966065824	0.742435413	HE	0.99971200	122.318
L719	-792.022948046	31.395737994	SIO2	1.56028895	136.726
	-284.699402375	0.732480789	HE	0.99971200	139.887
L720	-1399.942577177	28.528105133	SIO2	1.56028895	152.678
	-405.074653331	0.721634536	HE	0.99971200	154.617
L721	969.181518515	52.876050649	SIO2	1.56028895	166.429
	-498.113891823	15.463597200	HE	0.99971200	167.335
	infinite	-10.309064800	HE	0.99971200	163.661
L722	369.912797108AS	22.457291722	SIO2	1.56028895	164.702
	546.240476474	0.759815621	HE	0.99971200	163.421
L723	435.783427872	59.712335014	SIO2	1.56028895	163.043
	-757.138748183	38.604277894	HE	0.99971200	161.173
L724	-268.662949002	15.463597200	SIO2	1.56028895	159.696
	-299.983850179AS	20.130367113	HE	0.99971200	160.684
L725	-232.880394011AS	19.892839003	SIO2	1.56028895	159.263
	-238.077482924	0.721634536	HE	0.99971200	162.099
L726	238.488298578	23.631362631	SIO2	1.56028895	127.621
	378.766536032	0.721634536	HE	0.99971200	124.291
L727	136.105324171	29.608483074	SIO2	1.56028895	108.001
	205.107042559	0.785819222	HE	0.99971200	104.429
L728	143.303538802	37.757018324	SIO2	1.56028895	96.584
	1247.979376087AS	8.449273703	HE	0.99971200	91.946
L729	infinite	26.717587971	CaF2	1.50143563	85.145
	infinite	5.154532400	L710	0.99998200	65.152
L730	infinite	25.772662000	CaF2	1.50143563	54.537
	infinite	10.309064800	L710	0.99998200	35.251
L731	infinite	0.000000000			14.020

L710 = Air at 710 Torr

ASPHERIC CONSTANTS

Asphere of Lens L701

K	0.0000
C1	6.70377274e-008
C2	6.84099199e-013
C3	1.05733405e-016
C4	3.37349453e-020
C5	-7.15705547e-024
C6	5.09786203e-028
C7	-6.46970874e-033
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L704

K	-1.3610
C1	-2.19369509e-007
C2	7.67800088e-012
C3	-6.07796875e-015
C4	7.90645856e-019
C5	-9.11112500e-023
C6	5.68885354e-027
C7	-4.26463481e-031
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L705

K	-1.2060
C1	8.09444891e-008
C2	4.80824558e-012
C3	-4.20373603e-015
C4	5.60648644e-019
C5	-4.51520330e-023
C6	1.54505188e-027
C7	5.00741161e-032
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L707

K	0.0000
C1	7.63455153e-008
C2	-8.56292259e-012
C3	3.01669569e-016
C4	9.61573017e-021
C5	-2.67588216e-024
C6	2.05728418e-028
C7	-6.45595651e-033
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L709

K	0.0000
C1	3.23214391e-009
C2	-1.67326019e-013
C3	-4.26702152e-019
C4	-5.66712884e-023
C5	-1.24256704e-028
C6	1.64124726e-031
C7	-4.41379927e-036
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L714

K	0.0000
C1	-1.63753926e-009
C2	2.54837542e-013
C3	8.79430055e-018
C4	9.19127213e-022
C5	-7.01950932e-026
C6	1.17918461e-029
C7	-8.74308763e-034
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L716

K	0.0000
C1	-1.54725313e-008
C2	-4.26275476e-012
C3	-1.01484275e-016
C4	8.37843426e-022
C5	-1.29202167e-024
C6	1.71820044e-028
C7	-1.05335330e-032
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L722

K	-0.0331
C1	2.56540619e-011
C2	-6.98183157e-015
C3	7.92101859e-021
C4	-5.85807569e-025
C5	2.42288782e-028
C6	-5.79467899e-033
C7	1.63689132e-037
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L724

K	0.0000
C1	8.90820785e-011
C2	-1.06772804e-014
C3	-1.68281363e-019
C4	3.04828021e-023
C5	-1.01185483e-027
C6	1.61617917e-032
C7	-2.40582729e-037
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L725

K	0.0000
C1	-1.97757640e-010
C2	2.05110497e-014
C3	8.96864099e-019
C4	-9.85543257e-024
C5	-7.12993590e-028
C6	1.30146671e-032
C7	-1.36102788e-037
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L728

K	0.0000
C1	2.55097376e-008
C2	5.47467657e-013
C3	-1.43568713e-016
C4	1.17677649e-020
C5	-5.95320448e-025
C6	1.71763367e-029
C7	-1.94556007e-034
C8	0.00000000e+000
C9	0.00000000e+000

TABLE 8

L61

LENSES	RADII	THICKNESSES	GLASSES	REFRACTIVE INDEX AT 157.13 nm	1/2 FREE DIAMETER
0	infinite	34.000000000		1.00000000	82.150
	infinite	0.100000000		1.00000000	87.654
L801	276.724757380	40.000000000	CaF2	1.55970990	90.112
	1413.944109416AS	95.000000000		1.00000000	89.442
SP1	infinite	11.000000000		1.00000000	90.034
	infinite	433.237005445		1.00000000	90.104
L802	-195.924336384	17.295305525	CaF2	1.55970990	92.746
	-467.658808527	40.841112468		1.00000000	98.732
L803	-241.385736441	15.977235467	CaF2	1.55970990	105.512
	-857.211727400AS	21.649331094		1.00000000	118.786
SP2	infinite	0.000010000		1.00000000	139.325
	253.074839896	21.649331094		1.00000000	119.350
L803'	857.211727400AS	15.977235467	CaF2	1.55970990	118.986
	241.385736441	40.841112468		1.00000000	108.546
L802'	467.658808527	17.295305525	CaF2	1.55970990	102.615
	195.924336384	419.981357165		1.00000000	95.689
SP3	infinite	6.255658280		1.00000000	76.370
	infinite	42.609155219		1.00000000	76.064
Z1	infinite	67.449547115		1.00000000	73.981
L804	432.544479547	37.784311058	CaF2	1.55970990	90.274
	-522.188532471	113.756133662		1.00000000	92.507
L805	-263.167605725	33.768525968	CaF2	1.55970990	100.053
	-291.940616829AS	14.536591424		1.00000000	106.516
L806	589.642961222AS	20.449887046	CaF2	1.55970990	110.482
	-5539.698828792	443.944079795		1.00000000	110.523
L807	221.780582003	9.000000000	CaF2	1.55970990	108.311
	153.071443064	22.790060084		1.00000000	104.062
L808	309.446967518	38.542735318	CaF2	1.55970990	104.062
	-2660.227900099	0.100022286		1.00000000	104.098
L809	23655.354584194	12.899131182	CaF2	1.55970990	104.054
	-1473.189213176	9.318886362		1.00000000	103.931
L810	-652.136459374	16.359499814	CaF2	1.55970990	103.644
	-446.489459129	0.100000000		1.00000000	103.877
L811	174.593507050	25.900313780	CaF2	1.55970990	99.267
	392.239615259AS	14.064505431		1.00000000	96.610
	infinite	2.045119392		1.00000000	96.552
L812	7497.306838492	16.759051656	CaF2	1.55970990	96.383
	318.210831711	8.891640764		1.00000000	94.998
L813	428.724465129	41.295806263	CaF2	1.55970990	95.548
	3290.097860119AS	7.377912006		1.00000000	95.040
L814	721.012739719	33.927118706	CaF2	1.55970990	95.443
	-272.650872353	6.871397517		1.00000000	95.207
L815	131.257556743	38.826450065	CaF2	1.55970990	81.345
	632.112566477AS	4.409527396		1.00000000	74.847
L816	342.127616157AS	37.346293509	CaF2	1.55970990	70.394
	449.261078744	4.859754445		1.00000000	54.895
L817	144.034814702	34.792179308	CaF2	1.55970990	48.040
	-751.263321098AS	11.999872684		1.00000000	33.475
0'	infinite	0.000127776		1.00000000	16.430

ASPHERIC CONSTANTS

Asphere of Lens L801

K	0.0000
C1	4.90231706e-009
C2	3.08634889e-014
C3	-9.53005325e-019
C4	-6.06316417e-024
C5	6.11462814e-028
C6	-8.64346302e-032
C7	0.00000000e+000
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L803

K	0.0000
C1	-5.33460884e-009
C2	9.73867225e-014
C3	-3.28422058e-018
C4	1.50550421e-022
C5	0.00000000e+000
C6	0.00000000e+000
C7	0.00000000e+000
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L803'

K	0.0000
C1	5.33460884e-009
C2	-9.73867225e-014
C3	3.28422058e-018
C4	-1.50550421e-022
C5	0.00000000e+000
C6	0.00000000e+000
C7	0.00000000e+000
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L805

K	0.0000
C1	2.42569449e-009
C2	3.96137865e-014
C3	-2.47855149e-018
C4	7.95092779e-023
C5	0.00000000e+000
C6	0.00000000e+000
C7	0.00000000e+000
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L806

K	0.0000
C1	-6.74111232e-009
C2	-2.57289693e-014
C3	-2.81309020e-018
C4	6.70057831e-023
C5	5.06272344e-028
C6	-4.81282974e-032
C7	0.00000000e+000
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L811

K	0.0000
C1	2.28889624e-008
C2	-1.88390559e-014
C3	2.86010656e-017
C4	-3.18575336e-021
C5	1.45886017e-025
C6	-1.08492931e-029
C7	0.00000000e+000
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L813

K	0.0000
C1	3.40212872e-008
C2	-1.08008877e-012
C3	4.33814531e-017
C4	-7.40125614e-021
C5	5.66856812e-025
C6	0.00000000e+000
C7	0.00000000e+000
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L815

K	0.0000
C1	-3.15395039e-008
C2	4.30010133e-012
C3	3.11663337e-016
C4	-3.64089769e-020
C5	1.06073268e-024
C6	0.00000000e+000
C7	0.00000000e+000
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L816

K	0.0000
C1	-2.16574623e-008
C2	-6.67182801e-013
C3	4.46519932e-016
C4	-3.71571535e-020
C5	0.00000000e+000
C6	0.00000000e+000
C7	0.00000000e+000
C8	0.00000000e+000
C9	0.00000000e+000

Asphere of Lens L817

K	0.0000
C1	2.15121397e-008
C2	-1.65301726e-011
C3	-5.03883747e-015
C4	1.03441815e-017
C5	-6.29122773e-021
C6	1.44097714e-024
C7	0.00000000e+000
C8	0.00000000e+000
C9	0.00000000e+000